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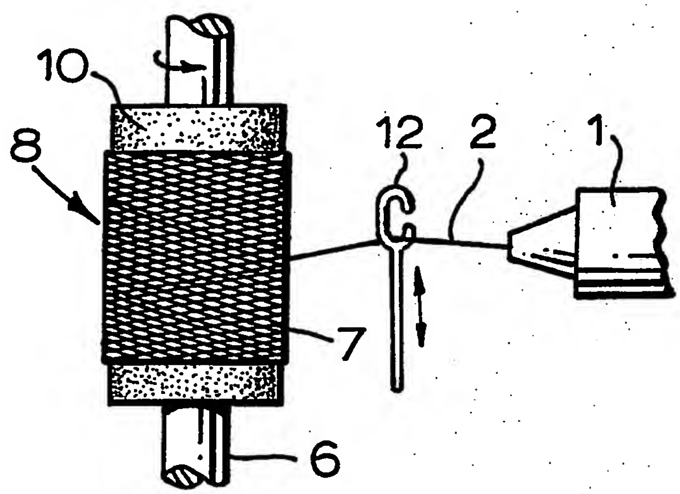

(57) Abstract

A gas heater having a hollow, generally cylindrical burner (18) and means to pass a gas/air mixture through it from a sup ply face to a combustion face, the burner being composed of filamentary ceramic material (2) formed from a plastic ceramic mi by extrusion drying and firing and regularly or randomly lying in closely spaced and mutually contacting convolutions bonde together at their contact points to constitute a self-supporting body having a stereo-reticulated porous structure.

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GAS HEATER

This invention relates to gas heaters.

Continuing problems have arisen in providing hollow gas burners of circular or other cross section combining sufficient physical strength in the material of the burner with resistance to hoop stress. Such stress arises from feeding gas air mixture through the body of the burner from one face to the other, usually from the inside to the outside but the other way round in, for example, wire annealing furnaces. The supply face is relatively cool, and must be kept that way to stop the burner lighting back. The heating face is, of course, at least at red heat and destructive stresses in a simple cylindrical body are inevitable. To avoid the problems, bodies of ceramic foam or cast fibre variously slotted or made up of separated components have been proposed but difficulties in achieving straightforward manufacture and durability in service have remained.

The present invention is to adopt as burners bodies made up of ceramic extrudates. Such bodies have hitherto been prepared as filters for molten metal and catalyst supports in high temperature conditions, as set out in published UK Patent Specification A 2 176 179, but unexpectedly operate excellently in this new use.

More particularly, the invention provides a gas heater comprising a hollow, generally cylindrical burner and means to pass a gas/air mixture through it from a supply face to a combustion face, the burner being composed of filamentary ceramic material (preferably of thermal expansion coefficient between room temperature and $1000^{o}C$ of less than $2x10^{-6}/^{o}C$ and more preferably less than $1x10^{-6}/^{o}C$) regularly or randomly lying in closely spaced and mutually contacting convolutions bonded together at their contact points and constituting a self-supporting body having a stereo-reticulated porous structure.

Such a burner may be of circular cross section or of any other regular or irregular, generally elongate form hollow in its length and the term cylindrical is to be understood accordingly. Gas/air supply may be premixed or by means of gas jet and venturi as well known per se.

The burners are conveniently made by extruding in filamentary form a plastic preparation of ceramic material and randomly or regularly laying the filamentary extrudate into closely spaced and mutually contacting convolutions constituting a self-supporting body having a stereo-reticulated porous structure, drying and firing the body.

In one method, random laying of extruded filamentary material, there is provided a hollow receiver, for extrudate, the receiver having a shape which is an envelope of the shape of the required body, regular or, for example for log-effect fire elements, irregular. For example, an open-ended cylindrical drum with a central core or inner peripheral wall, leaving an annular space, may be used as a receiver for making an annular cylindrical body with a wall of substantial, self-supporting, thickness. After forming, the body may be removed from the receiver and supported by a paper or other easily deformable mount which permits shrinkage on drying. Alternatively a rigid receiver may have a deformable foam or like core.

The extrudate, as a single extruded filament or multiple filaments, is directed into the mouth of the receiver and the extruder and receiver are moved relatively to each other to lay in the extrudate, which may be in random convolutions or regularly disposed, progressively to fill the receiver which serves as a mould for the shape of the body required. The relative movement may be effected by movement of either the receiver and/or the extruding head, and the shape, size and number of filaments extruded can be selected to give a

required porosity of the stereo-reticulated structure.

After extrusion, the receiver contents may be stabilized in form by moderate jolting of the receiver or light pressure applied to the accessible surface of the filament composing the body. This improves definition of the surface. Then, after initial setting in the receiver, and drying with or without heating in or out of the receiver, the built-up filamentary material body is fired.

In another method filamentary extrudate is regularly laid into convolutions by coil-winding of a single or multiple extruded filament substantially helically in multiple layers. Known methods applied to textile thread, wire or string for coil winding may be used for this purpose, and the filament spacing and diameter can be correlated readily to control effective pore size to give good burn characteristics. For example for 0.75 mm filament and for use with premixed gas and air a suitable spacing is 0.4 to 1.2 mm preferably 0.6 to 1.0 mm. Corresponding figures for other filaments or for self aerating burners with gas fed to a venturi are readily found by trial.

The invention is illustrated by way of example in the accompanying drawings, in which:

Fig 1 is a perspective illustration of making a burner by extruding a filament to form random convolutions in a receiver;

Fig 2 is a diagrammatic illustration of making a burner by coil-winding of an extruded filament; and

Fig 3 is a diagrammatic illustration of a gas heater incorporating the burner of Fig 2.

As illustrated in Fig 1, an extruder 1 directs an extruded filament 2 down into a cylindrical receiver 3 while the extruder is moved relatively to the receiver in horizontal directions, as indicated by the arrows, and the receiver is

rotated about an axis spaced from the mean axial position of the extruder. The result is to build up in the receiver 3 a randomly convoluted, but reproducible, filamentary accumulation 4 in which the convolutions intermittently contact and are spaced at close intervals. The extrudate is tacky enough for the convolutions to interadhere at their points of contact, but not so as to stick to the receiver and make the resulting burner body difficult to remove, and the body formed takes on the regular or if desired irregular shape of the receiver. (An irregular receiver would for example be required to form log effect burner bodies, and would require to be split into two or more mould portions to allow them to be removed).

When the receiver 3 is full, the contents are stabilized by joggling or lightly compacted, allowed to set and dry, or are simply dried, until firm enough to be removed from the receiver as a self-supporting cylindrical body which is fired after such further drying as may be required. The stereo-reticulated structure of the body is irregular, without any discrete layer structure.

Fig 2 shows an extruder 1 from which a filament 2 is laid on to a former 10 on a horizontal rotating spindle 6 in helical convolutions 7 resulting from lateral movement in per se known way, as indicated by the arrow, of a thread guide 12 relatively along the spindle 6 to build up a tubular body or annulus 8. Lying above the former 10 parallel to the spindle 6 (but for clarity not shown) is a roller bearing lightly on the body 8, to consolidate it as it grows.

By making the former 10 of foam or other deformable material, on which the filament 2 is wound, allowance is made for shrinkage during drying.

After setting and drying, the body 8 is removed from the spindle, with or without the former, and fired to produce a

self-supporting wound filamentary annulus in which the filamentary material extends substantially helically in multiple convoluted layers. The advantage of this method is that the hole size formed between the strands can be progressively altered, by adjustment of the spindle speed and the lateral movement speed of the thread guide to give a smaller hole on the inner bore and a larger one on the outside, reducing any light back tendency and approximating what may be considered an idealised hole geometry.

As already noted, ceramic compositions with a low coefficient of thermal expansion should be used. Suitable preparations for filamentary extrusion are, for example, low alkali content cordierites, and certain lithium aluminium silicates, for instance petalite (a lithium mineral Li_20. Al_20_3. 8 $Si0_2$ sp. gr. 2.45 m.p. 1350^oC), thermal expansion coefficient $0.7x10^{-6}/^oC$.

The water required to produce an extrudable paste is usually provided, as in the examples below, by the plasticizer.

The physical properties of the ceramic preparation should be:

A. Soft and plastic enough to extrude through a fine nozzle, e.g. 0.2 - 0.6mm, though larger diameter filaments may be used. This property can be controlled by adjustment of the binder content.

B. The extruded filament should have sufficient tensile strength and cohesion, to retain its water during extrusion and withstand laying or winding, whilst remaining soft and plastic enough to conform to the shape of the former, and tacky so as to adhere to contacted filaments. These properties are controllable by the glycerine or wax content, glycerine in particular acting as a drying control additive.

Examples of suitable compositions are; in parts by weight:

Composition I - Suitable for the method of Fig. 1

Lithium Carbonate	10.7
China Clay	37.3
Quartz	52.0
Glycerine	10
Plasticizer, in aqueous solution	17

Composition II - Suitable for the method of Fig. 2

Lithium Carbonate	10.7
China Clay	37.3
Quartz	52.0
Wax	5
Plasticizer, in aqueous solution	24

For both compositions, a suitable plasticizer is a 5% aqueous solution of M 450 Celacol (Trade Mark) which is a carboxy methyl cellulose acting as an extrusion aid and as a binder when the composition has set. The wax is a soft paraffin wax binder, Okerine wax, of low melting point, about 40°C, that is to say some 10° or 15°C above normal ambient temperature, and gives residual plasticity when the composition has set. It also acts as an extrusion aid.

As an example of the application of the new burners, a water heater construction is diagrammatically shown in Fig. 3. The burner 8 lies in a housing within a tank 14 and is fed with gas/air mixture under the control of a thermostat 15. Insulation is indicated at 18. The burner is of approximately 4 inches (10cm) diameter. Combustion gases escape through a baffled internal flue 16 and an exit flue 17. Details of the burner are:

Coil Details: Petalite extrusion body using Composition II above wound onto 18mm former, pitch 1.75 mm (spacing between threads 1.0 mm), air dried for 24 hours and fired to 1240°C.

Fired dimensions	(mm)	
Length	100	
Internal diameter	17	(5% Shrinkage)
Thread diameter	0.75	

Flow rates [mixture at mains pressure]	l/min
Gas (mains natural gas i.e. methane)	3
Air	47

Good burn characteristics were achieved and the coil showed no cracking during burning or after cooling even when forced cooling was used.

CLAIMS

1. A gas heater having a hollow, generally cylindrical burner and means to pass a gas/air mixture through it from a supply face to a combustion face, the burner being composed of filamentary ceramic material (preferably of thermal expansion coefficient between room temperature and 1000^{o}C of less than $2x10^{-6}/^{o}C$ and more preferably less than $1x10^{-6}/^{o}C$) formed from a plastic ceramic mix by extrusion drying and firing and regularly or randomly lying in closely spaced and mutually contacting convolutions bonded together at their contact points to constitute a self-supporting body having a stereo-reticulated porous structure.

2. A gas heater according to Claim 1, in which the filamentary material of the burner extends in convolutions multi-directionally so that the stereo-reticulated structure is irregular, without any discrete layer structure.

3. A gas heater according to Claim 1, in which the filamentary material of the burner extends as a coil-wound structure, the material extending substantially helically in multiple layers with regularly spaced gas passages.

4. A gas heater according to Claim 3 in which the diameter of the gas passages increases from the supply face to the combustion face.

FIG.1

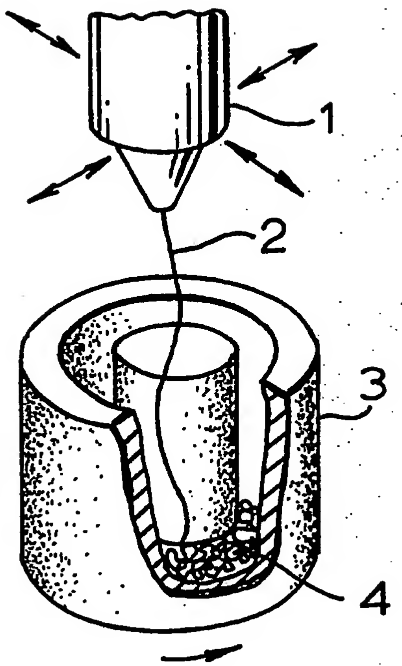

FIG.2

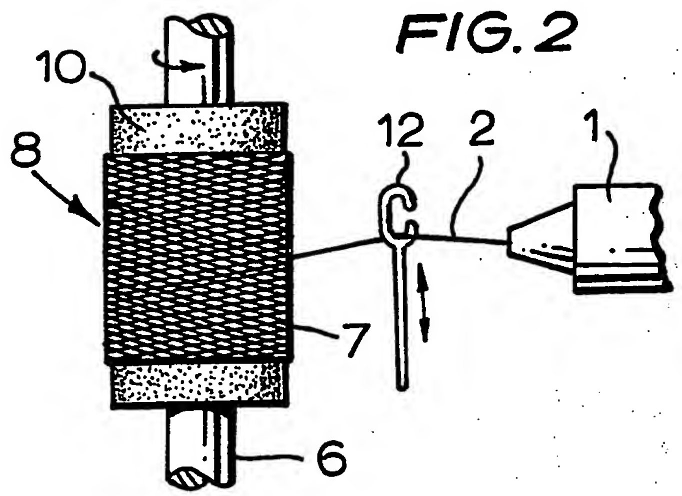

FIG.3